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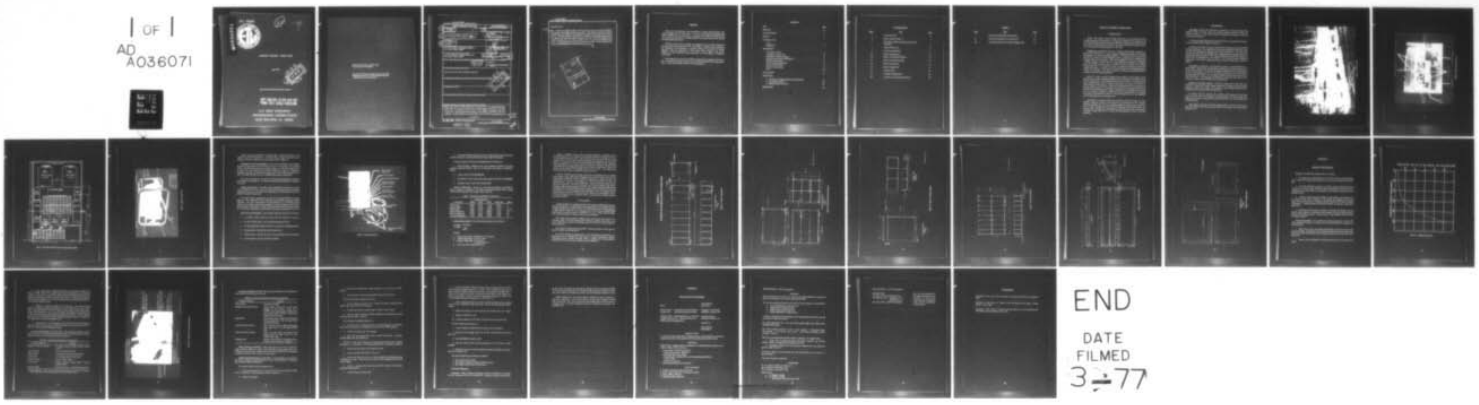

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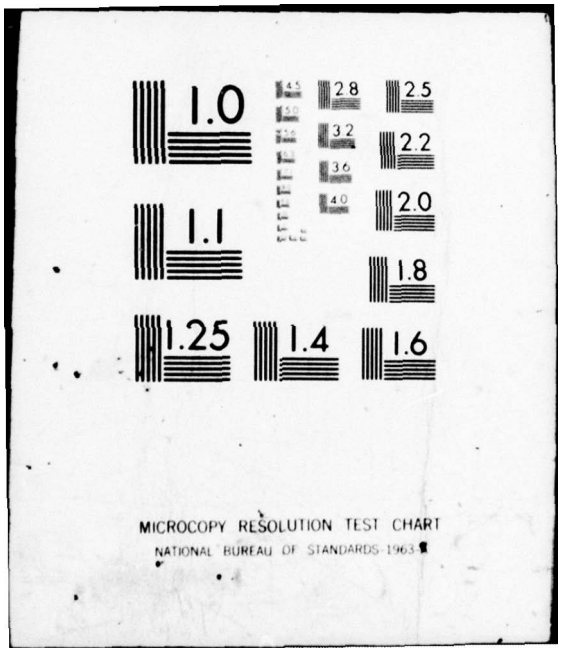
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CHARGING EQUIPMENT, MOBILE (CEM)

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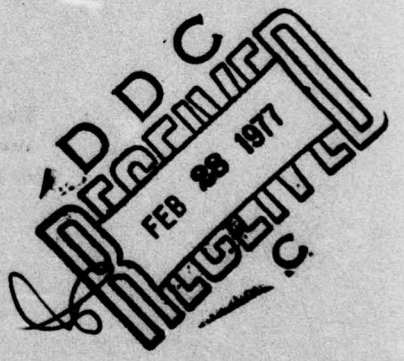

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report covers the design, fabrication, test, and operation of the Charging Equipment, Mobile (CEM) which provides a mobile battery charging capability to field units. The design and fabrication was performed in-house at the U.S. Army Engineer Topographic Laboratories to support the Long Range Position-Determining System (LRPDS). The CEM has been used specifically to recharge BB-451/U, silver-zinc batteries used with LRPDS backpackable ground

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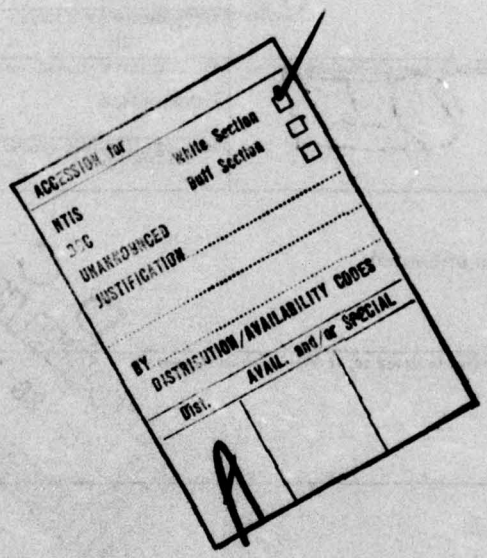
units. However, the dialable voltage cutoff in the battery charger will permit recharge of silver-cadmium and lead-acid batteries, among others. The equipment was used extensively in the field tests of the LRPDS for charging BB-451/U batteries at 2.25 amperes with a cutoff at 32 volts. Although activation of the BB-451/U batteries is a slow and painstaking operation, nine batteries were easily and reliably recharged at one time. Besides the operational tests, a safety evaluation and a road test were made by the U.S. Army Test and Evaluation Command. No unusual hazards were found, and there was no evidence of physical damage after runs over the Munson Road at the Aberdeen Proving Ground.



PREFACE

This work was performed under the authority of Project 1J664716D578, "Surveying Equipment for the Field Army," Task 12, Long Range Position-Determining System (LRPDS) and was undertaken as a subtask of the LRPDS to fulfill the need for a ready and rapid means to recharge BB-451/U silver-zinc batteries used with the 29 backpackable ground units.

The floor plan and the mountings were designed by Jack Jacobson; fabrication was supervised by Jack Jacobson and F. Lewis Wilson. Assistance in the operation of the equipment and preparation of operating manuals was provided by Richard Basehore, under the supervision of Steve Nagy, Project Engineer and Carl R. Friberg, Jr., Chief, Electronics Surveying Branch, U.S. Army Engineer Topographic Laboratories.

The equipment was used in the LRPDS acceptance tests conducted by Motorola, Inc., Government Electronics Division, and in the Operational II tests conducted by the U.S. Army Field Artillery Board at Fort Sill, Oklahoma.

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ILLUSTRATIONS

TABLES

CHARGING EQUIPMENT, MOBILE (CEM)

INTRODUCTION

Scope. This report covers the design, fabrication, test, and operation of the Charging Equipment, Mobile (CEM). The CEM was originally built in support of the Long Range Position-Determining System (LRPDS) to recharge the BB-451/U batteries used with the backpackable ground units. The design of the CEM was chosen to provide a mobile battery charging capability to field units.

Background. Compelled by the need to recharge a large number of batteries required by the LRPDS, the U.S. Army Engineer Topographic Laboratories (ETL) began investigations of existing recharging capabilities. In November 1972, it was learned that the U.S. Marine Corps had designed a trailer mounted battery charging system using PP/6241/U battery chargers. The battery charging system was never adopted as a military standard. However, the U.S. Army Electronics Command recommended using the PP/6241/U charger with the BB-451/U batteries selected for the LRPDS backpackable units. ETL conducted a series of recharge tests using the recommended chargers and batteries. From these tests, the general layout of the charging equipment concept was developed. The concept required no hardware development because it primarily interfaced existing equipments.

Based on a trailer mounted charging system similar to that evaluated by the Marine Corps, a battery charging arrangement for nine batteries was provided. In addition the standard ¾-ton cargo trailer provided room for storage of 16 preactivated or fully charged batteries, bins for storage of electrolyte, and a small work area for the initial activation of the batteries. Primary and back-up generator sets were selected as the main source of power. As an option, the use of power from an external source was included in the electrical circuitry. Safety requirements were established to insure that there was adequate ventilation to diffuse the hydrogen gas generated in the recharge and storage of the BB-451/U batteries. Ventilation requirements were also established for the exhaust gases from the generator sets.

Fabrication of mounting brackets and hardware was done by the U.S. Army Mobility Equipment Research and Development Command from ETL drawings. Following assembly and test of the charging capability, the entire system was taken to the U.S. Army Aberdeen Proving Ground for environmental testing and safety evaluation. After a successful test and evaluation period, the system was used in support of LRPDS during field tests in Arizona and Development II tests at Fort Sill, Oklahoma.

DESCRIPTION

Description of CEM. The CEM trailer is a standard U.S. Army ¾-ton cargo trailer (M101A1) with a removable canvas top to allow charging of batteries during most weather conditions. A ¾-ton truck is used for towing the CEM during over-the-road travel as shown in figure 1.

The major operating components on the trailer are the two gasoline-driven generator sets and three battery chargers (see figure 2).

Included in the trailer are battery storage bins and a potassium hydroxide (KOH) storage compartment. Two 5-gallon (19.4 liters) cans for gasoline are provided, which are used for extending the operating time of the generator sets. Two 8-foot (2.4 meters) rubber hoses are also included, which enables generator operation from external gasoline storage containers. The control switching box provides the selection of either of the two generator sets (see figure 2). An overall floor plan, showing the arrangement of the major components and the storage compartments, is shown in figure 3.

Description of Generators. The generator set (figure 4), Model MPF-015A, is a skid-mounted, tubular-frame, gasoline-driven generator that provides primary power for the battery chargers. The generator supplies 120 VRMS (volts root mean square), 60 Hz (1.5 KW) single phase power to the control switching box via a 3-conductor, 8-foot-long cable (2.4 meters). For a complete description of the generator set, refer to TM 5-6115-323-15. The generators are mounted on aluminum racks that are fabricated in accordance with specifications shown in figure A6.

Description of Battery Charger. The battery charger used in the CEM is the PP-6241/U, a portable, 3-channel battery charger that contains precision solid-state electronic controls. The charger was developed to meet military requirements for charging silver-zinc batteries such as the BB-451/U.

The battery charger is designed with a dialable cutoff voltage in 0.1-volt steps from 0.0 to 36.0 volts. The advantage of having a dialable cutoff voltage is that these chargers can be used to charge batteries other than silver-zinc, e.g., silver-cadmium and lead-acid batteries.

Each charger is provided with three charging cables, one power cable, and one instruction manual. The cables are located under the secondary cover of the detachable main cover.

Figure 1. Truck and Trailer

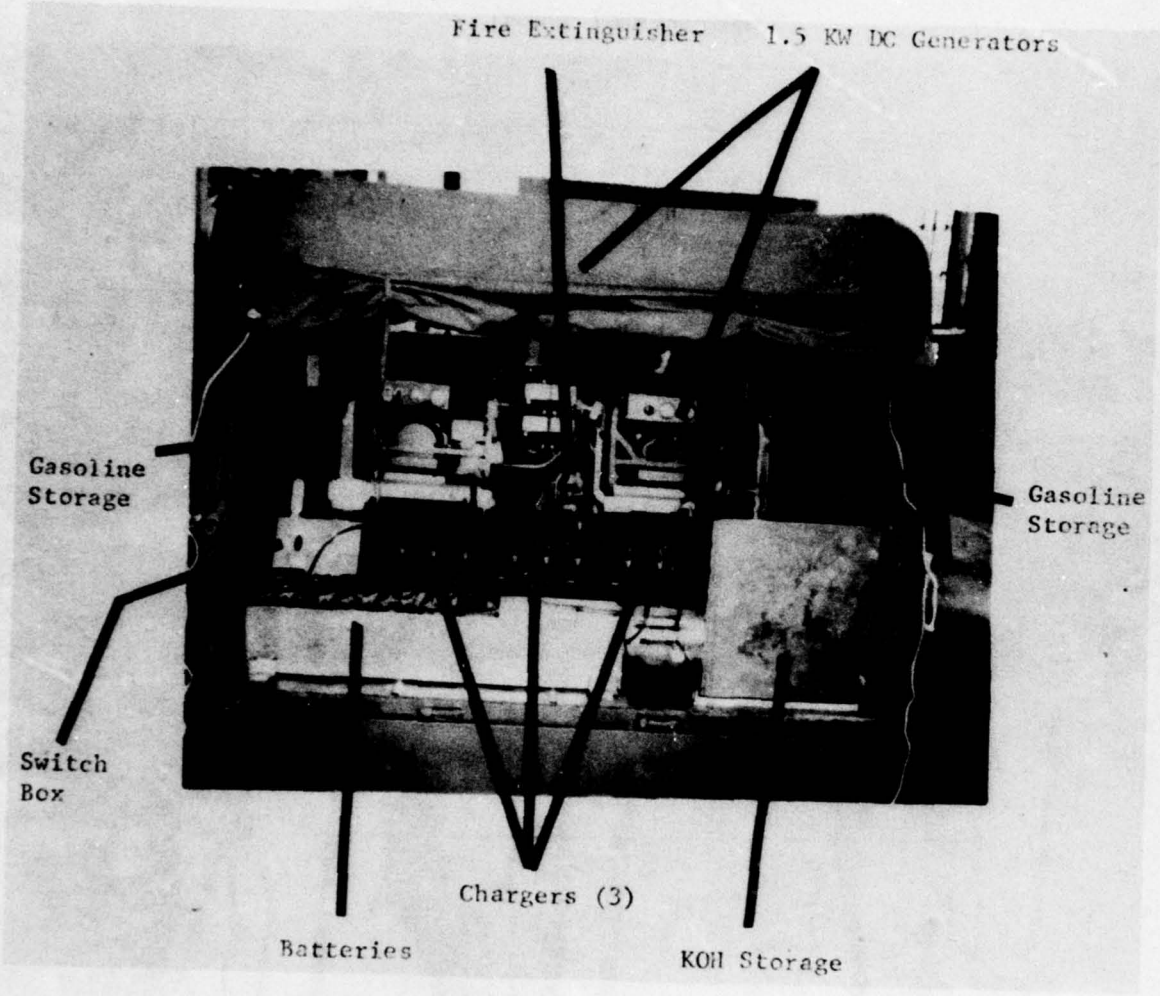

Figure 2. Major Component Layout

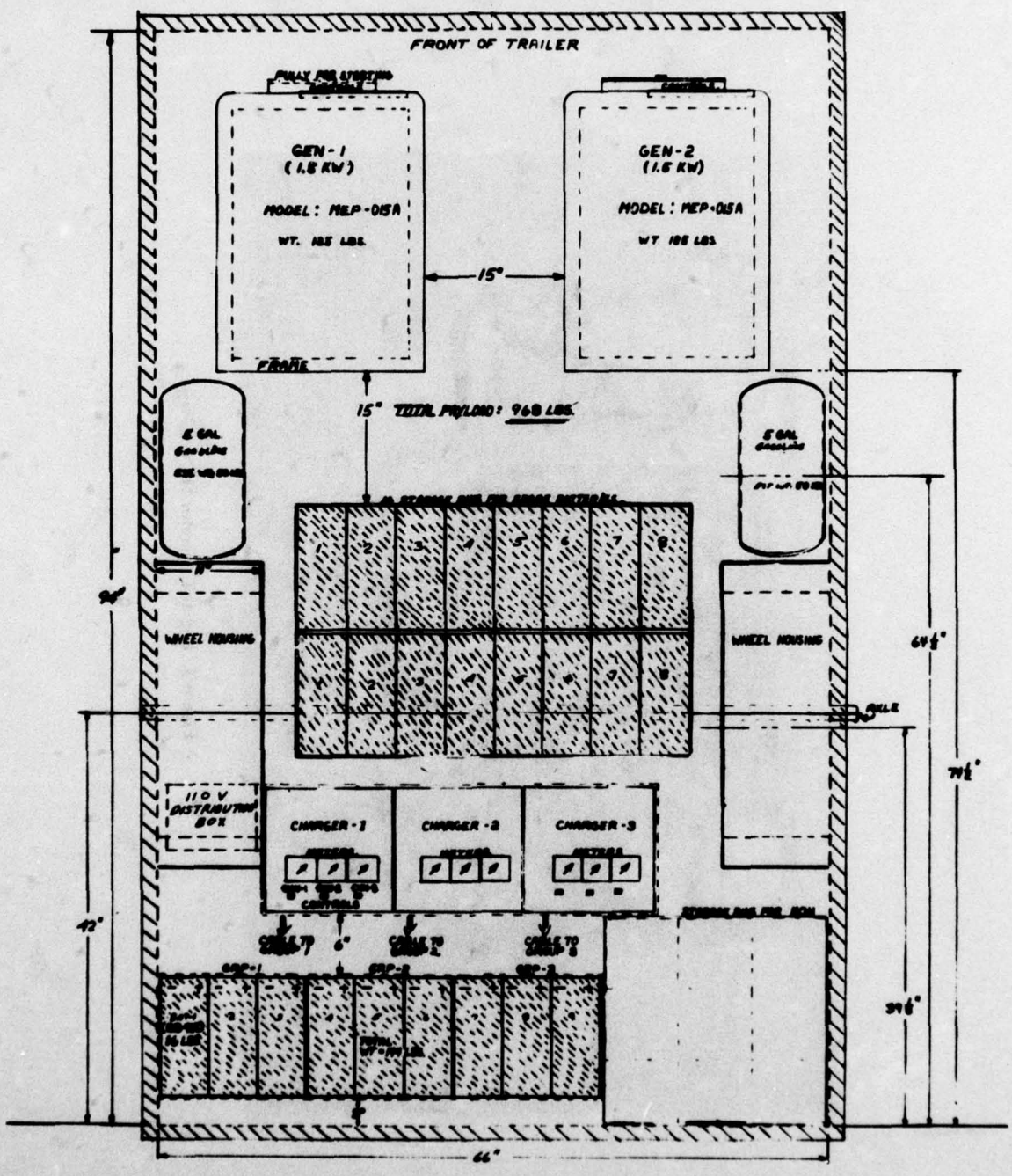

Figure 3. Floor Plan of M101AT Trailer and Associated Assemblies

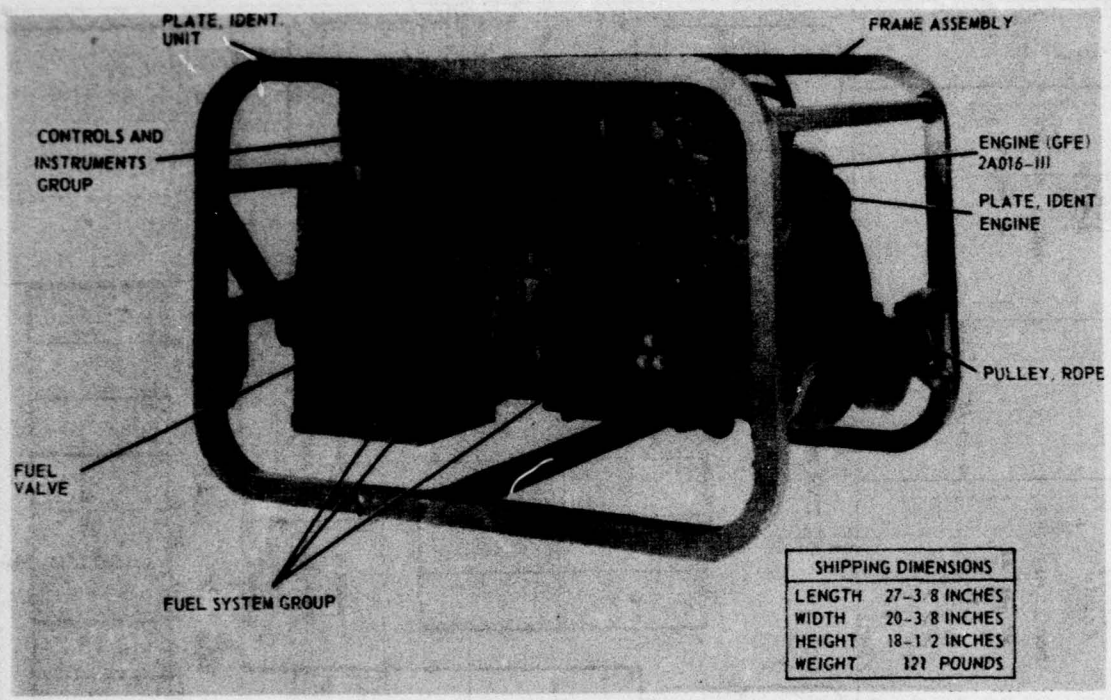

Figure 4. Engine Generator Set

Figure 5 displays the PP-6241/U, including cables. Detailed information on the charger is found in TM 04531A-15. The three battery chargers are mounted on an aluminum rack that is fabricated from specifications shown in figure A5.

Description of Control Switching Box. The control switching box uses a manual, heavy-duty four-position switch with two OFF and two ON positions. The switch is used to route the output power from either generator to a common receptacle, where the three AC power cables from the battery chargers are connected. Switching is arranged so that only one generator can supply power to the output receptacles at any time. Neon light indicators are used to display which generator is being used.

The control switching box is fastened to the left wheel housing of the trailer by four machine screws (figure 2). The output receptacles are protected by an aluminum cover plate.

Storage Compartments. The KOH storage compartment is fabricated in accordance with figures A2 and A3. Sixteen boxes of KOH electrolyte can be stored in this compartment with two of the bins in the compartment used for storing the electrolyte antidotes (vinegar and boric acid).

Two open storage compartments are used for storing the BB-451/U batteries (figure 2). One compartment is used to house up to nine batteries during the charging operations. The other compartment will accommodate up to 16 batteries and is mainly used for battery storage during transport. To prevent vertical movement of the batteries during CEM transport, a heavy duty strap is provided for securing the batteries. These open compartments are fabricated in accordance with figures A1 and A4.

Special Tools and Equipment. The standard equipment included in the CEM are:

1. A voltmeter, Weston model 911, with a full scale accuracy of 1 percent.
2. Six pairs of rubber gloves to be used during charging operations.
3. Six full length plastic aprons to be used for protection of clothing and body.
4. Grounding bar as a grounding element for generators.
5. Sledge hammer, 3.16 kg to be used to drive grounding bar into the ground.
6. Fire extinguisher, class B/C, FSN 4210-555-8837.

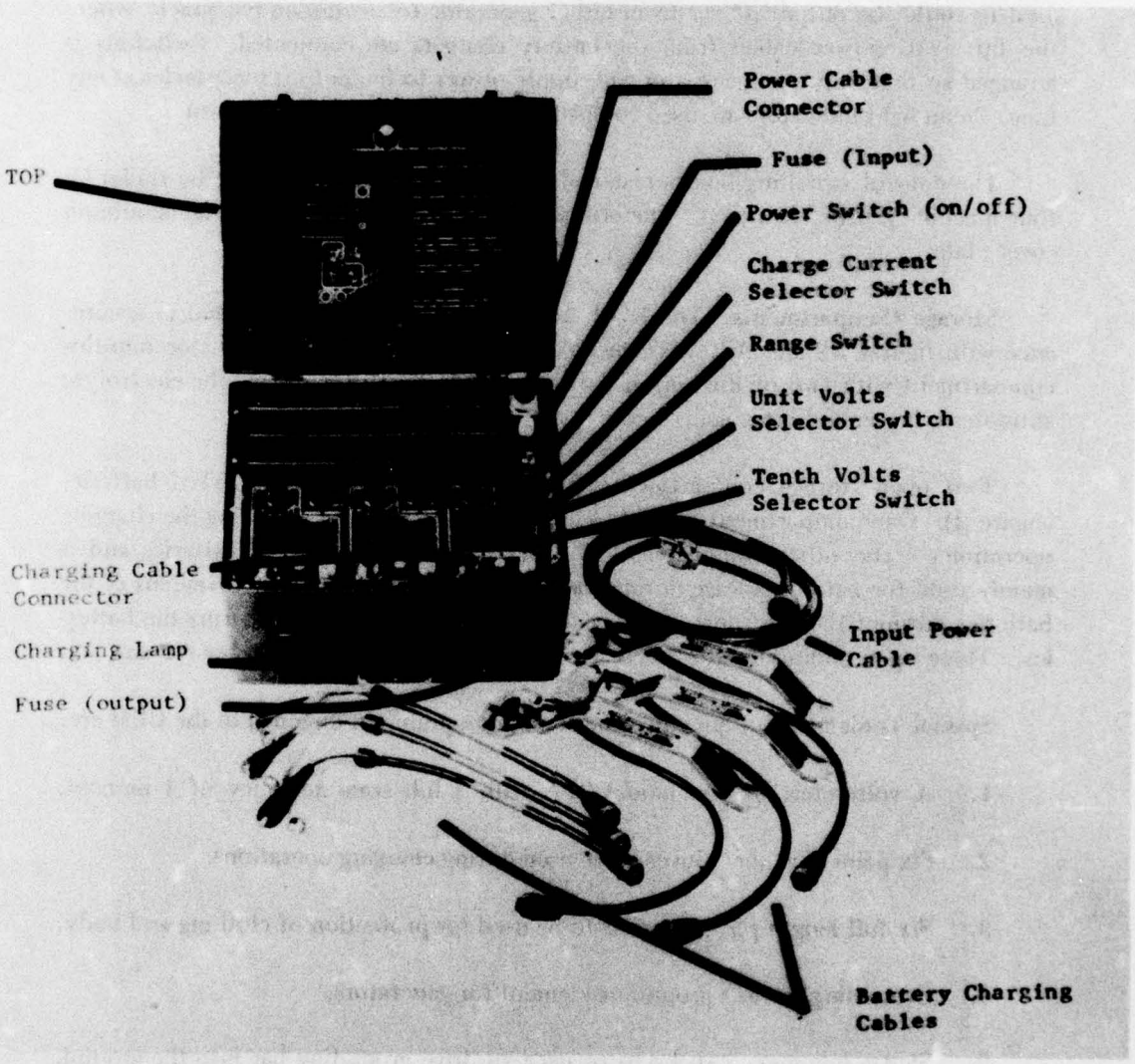

Figure 5. Controls and Indicators

7. One pint of diluted vinegar and one pint of saturated boric acid to be used as antidotes in the event of external or internal contacts with the electrolyte.

Tools and equipment needed when charging BB-451/U batteries are:

1. KOH electrolyte: Eighteen boxes, each containing 16 bottles of premixed potassium hydroxide (KOH). One box of electrolyte will activate one BB-451/U battery.

2. Torque wrench, FSN 5120-585-8434.

3. One-half-inch socket wrench with ¼-inch square drive, FSN 5120-189-8610.

4. Extension socket wrench, FSN 5720-227-8105.

Layout of CEM Trailer. The layout of the major components of the CEM are shown in figures A1 through A6. The major components are listed in table 1, along with the overall dimensions and weight of each component.

Table 1. Dimensions and Weights of Components

Component	Dimensions (cm)			Weight (kg)	Figures
	Height	Depth	Width		
Generator Set	50.00	69.53	51.75	56.70	4
Battery Charger	27.94	31.33	35.05	16.94	5
KOH Storage	59.06	38.10	46.04	31.75	A2, A3
Battery Storage (9)	19.05	31.75	100.01	13.61	A1
Battery Storage (16)	19.05	62.23	100.01	22.68	A4
Control Switching Box	17.78	20.95	25.40	2.27	2

Technical Characteristics. The technical characteristics of the CEM are:

Generator: 115 VRMS
(1.5KW) 1 ϕ
60 Hz

Chargers:

1. Output current range: Selectable 1.0 or 2.25 amps.
2. Cutoff voltage range: 8, 16, or 32 volts.
3. Dialable voltage range: 0.1-volt steps
   0.1-volts to 36.0 volts
4. Power drain (each charger) 460 watts.

Tests. In addition to the testing conducted during the investigative period, environmental tests were conducted on the Munson Road Test Course at the U.S. Army Aberdeen Proving Ground. After the road test on each of the four test course sections, there was no evidence of physical damage to the equipment. The test record, included as Appendix C, showed no unusual hazards associated with the equipment. Three suggestions for safety improvement were made; (1) attachment of labels warning of hazard related to charging, (2) replacement of plastic eyeshield with a plastic face shield, and (3) addition of appropriate gloves to the tool kit. The testing at the Aberdeen Proving Ground was completed during June 1973.

With the completion of the Munson Road Test, the charging system was assigned to the support of the LRPDS then undergoing field acceptance testing. Because of the small number of BB-451/U batteries available at that time, the charger was used on a limited scale but was able to accumulate over 100 hours of battery activation and recharging time without a system malfunction. Final operational testing was conducted in conjunction with the Development Test II (service phase) of the LRPDS. Transport of the charging equipment from Phoenix, Arizona to Fort Sill, Oklahoma was accomplished by commercial vehicle carrier. Another period of 160 hours of operation was placed on the system during the Fort Sill testing. Power was supplied for the battery chargers from both of the generator sets and from an external power source. As with the earlier tests, no equipment failures occurred and the charging operation proceeded smoothly.

CONCLUSIONS

Charging facilities for maintaining the ECOM recommended BB-451/U, silver zinc batteries required for the Long Range Position Determining System (LRPDS) were not available through Army supply channels. The LRPDS requirement for maintaining up to eight BB-451/U batteries, on a continuing basis at each of three separated mobile ground support locations required consideration of a van or trailer mounted facility with a self-contained power source, storage area, and work space.

The mobile, trailer-mounted, charging system developed by ETL proved to be extremely useful in the field charging and maintenance of BB-451/U batteries. The system functioned in support of Acceptance Tests and DT/OT II without a malfunction or breakdown.

The system as designed has the capability of supporting numerous other types of batteries in addition to the BB-451/U.

The system could prove ideally suited to the field charging and maintenance of batteries used in the deployment of such items as: distance measuring or azimuth determining devices; portable detection devices, navigation aids, communications equipment, and many other types of battery powered equipment.

APPENDIX A

DRAWINGS OF CHARGING EQUIPMENT, MOBILE (CEM)

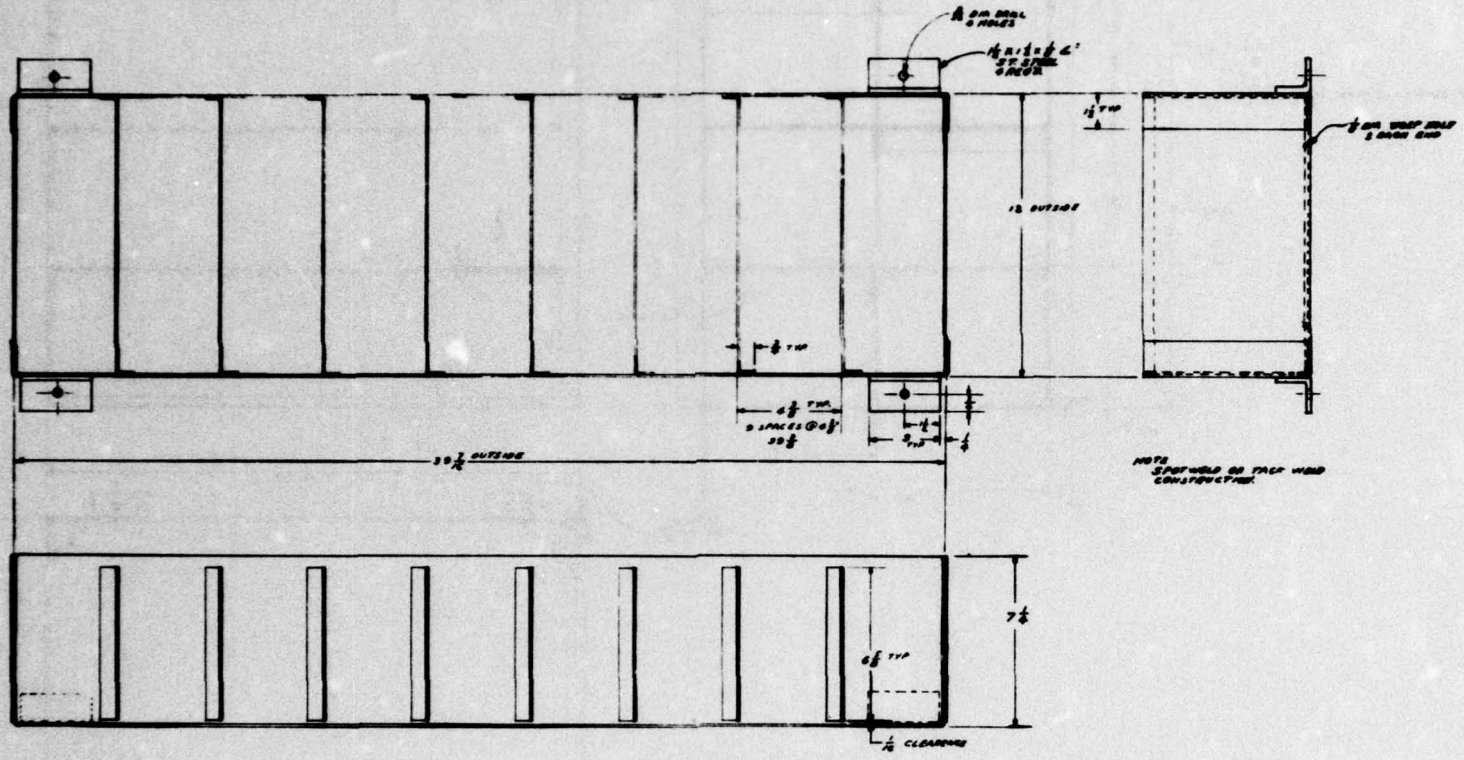

Figure A1. Battery Charging Rack

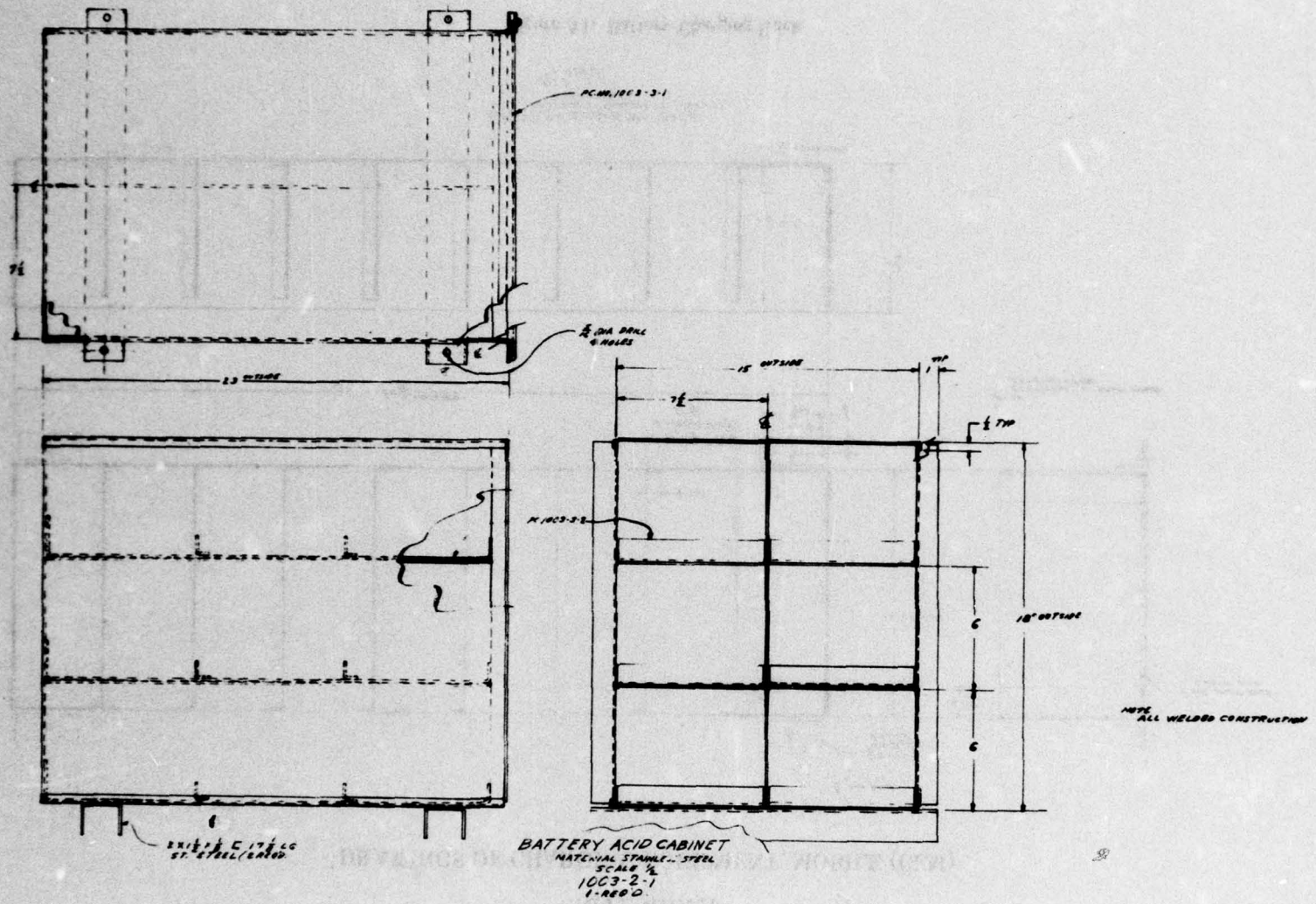

Figure A2. Battery Acid Cabinet Weldment

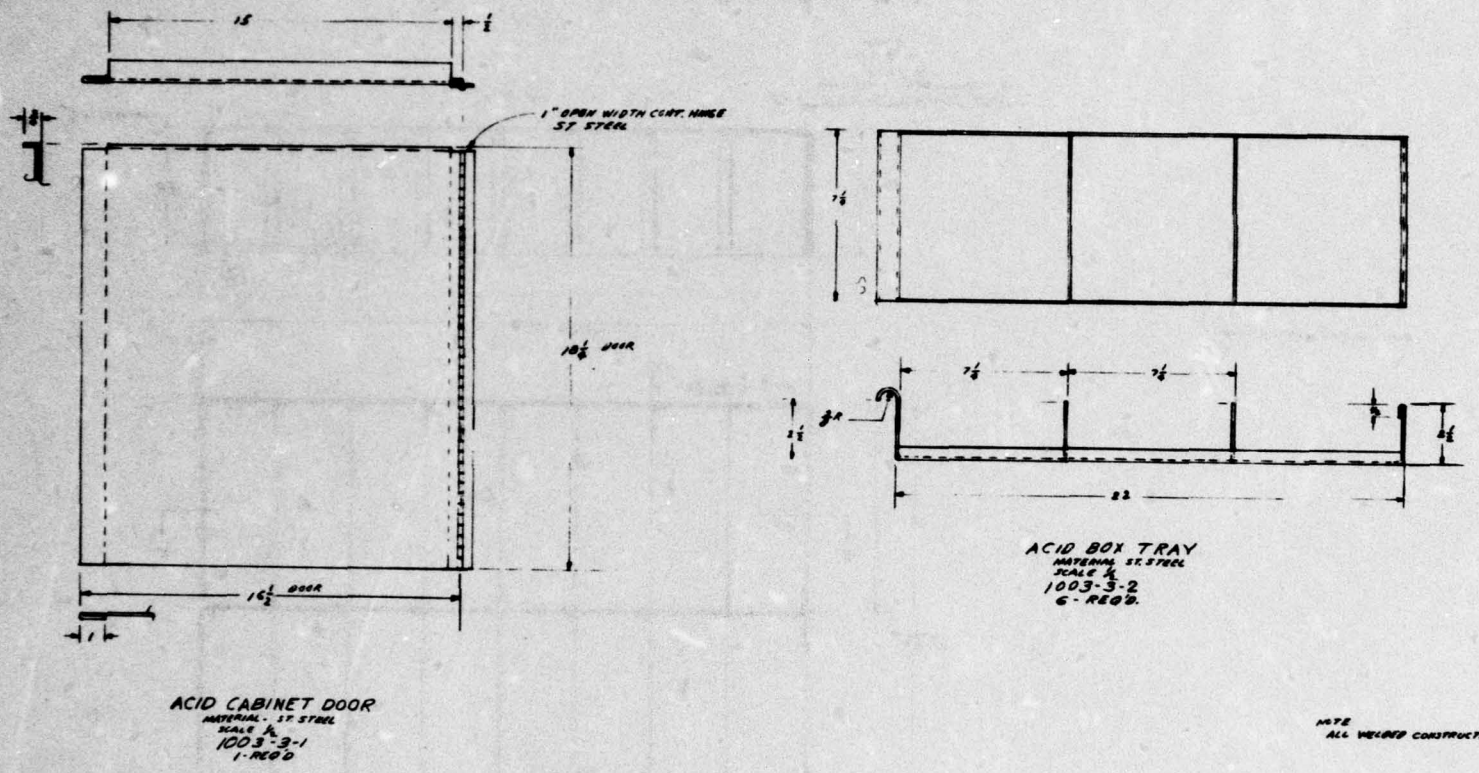

Figure A3. Battery Acid Cabinet Details

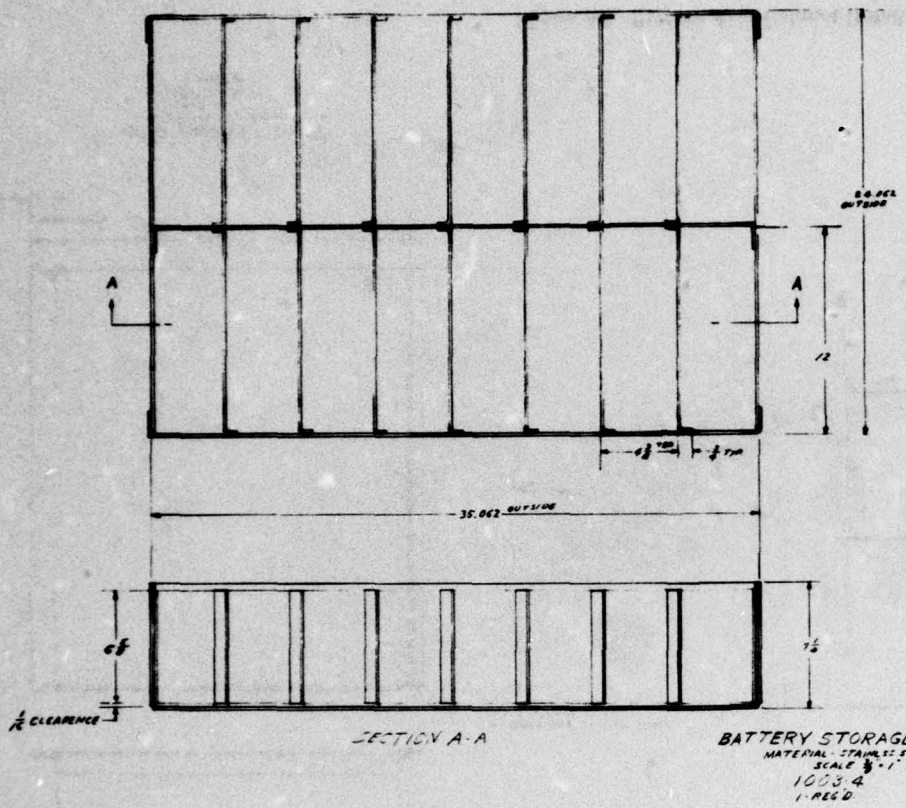

Figure A4. Battery Storage Rack

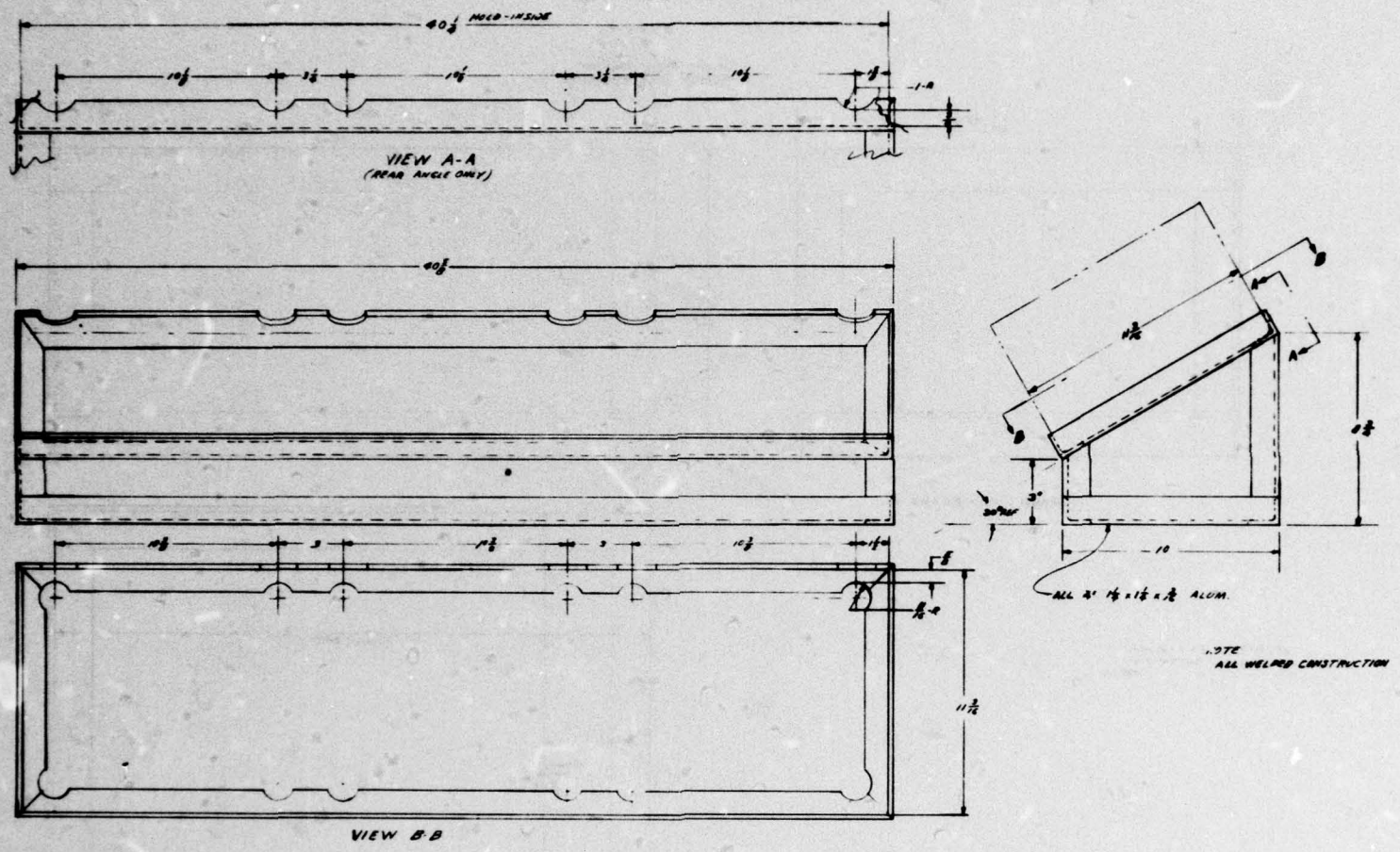

Figure A5. Battery Charger Rack

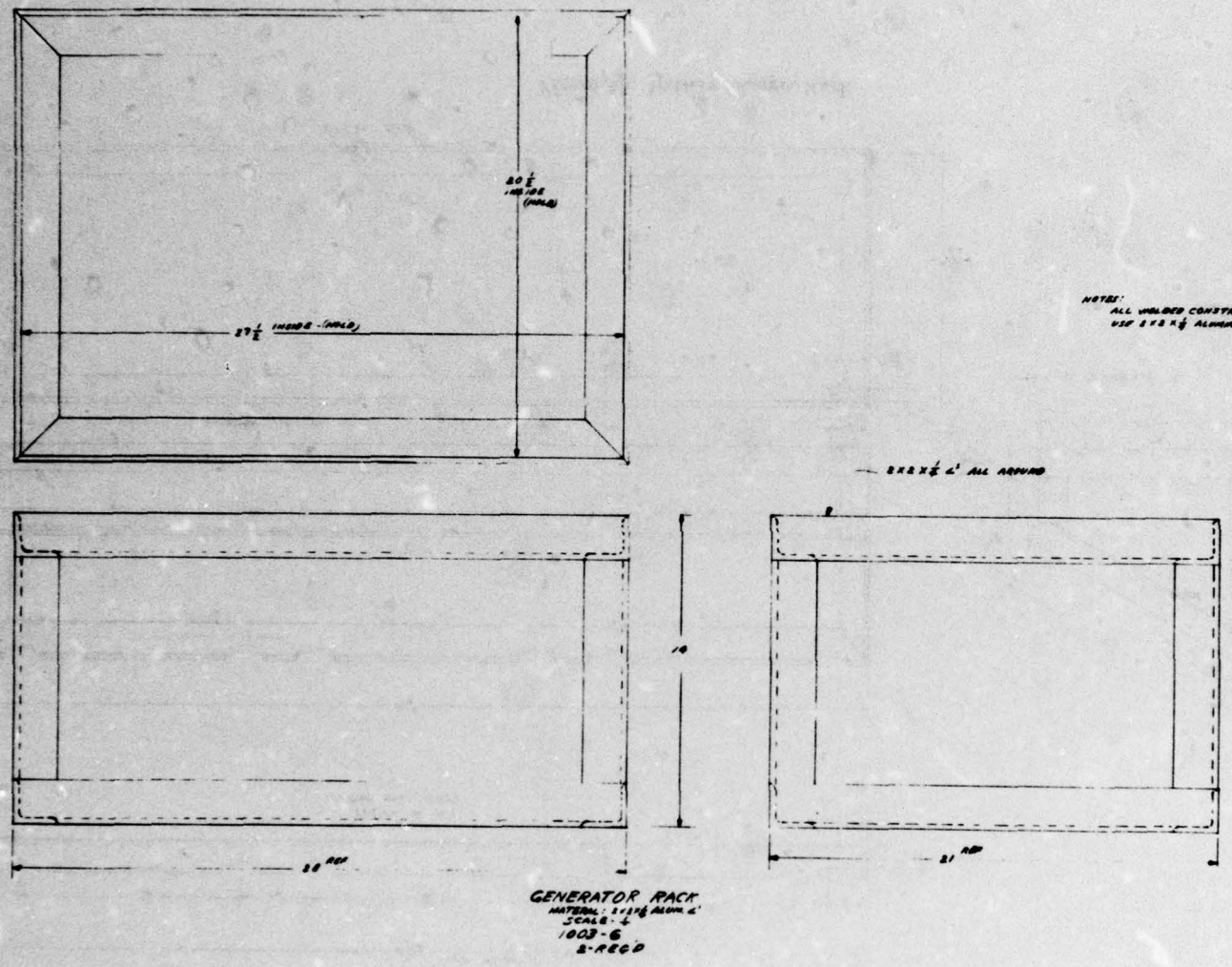

Figure A6. Generator Rack

APPENDIX B

OPERATING PROCEDURES

Warnings. The following warnings are given to operators:

1. Be careful when working around the 115 VAC connections at the generator sets. Contact with unprotected terminals or connectors can cause death by electrocution.

2. DO NOT OPERATE generator set until the ground terminals have been connected to a suitable ground. Electrical faults in the generator sets, power lines, or charging units can cause death by electrocution when contact is made with an ungrounded system.

3. Activated batteries generate hydrogen gas and explosive concentrations can be reached unless proper ventilation of the storage and charging area is assured. Figure B1 shows the amount of ventilation required in cubic feet per minute at varying temperatures. Ventilating requirements increase sharply at storage area temperatures above 80° F.

4. Electrolyte used in batteries is alkaline; it will cause skin irritation and will destroy fabric if spilled. Contamination with potassium hydroxide (KOH) should be treated with antidotes provided. If needed, report to the hospital or first aid station for further treatment.

Setting Up Procedures. After reaching the desired operating site, with the CEM trailer uncoupled from the tow vehicle, lay out and interconnect the equipment as described below.

1. Open front and rear canvas flaps, including side windows and curtains, and secure with straps. Swing gates to side of chassis and attach with L bolts. Remove the ground rod (with attached cable) from front gate and drive the rod at least 50 cm into the ground.

2. Remove the fire extinguisher from the trailer and place it by the back of the trailer.

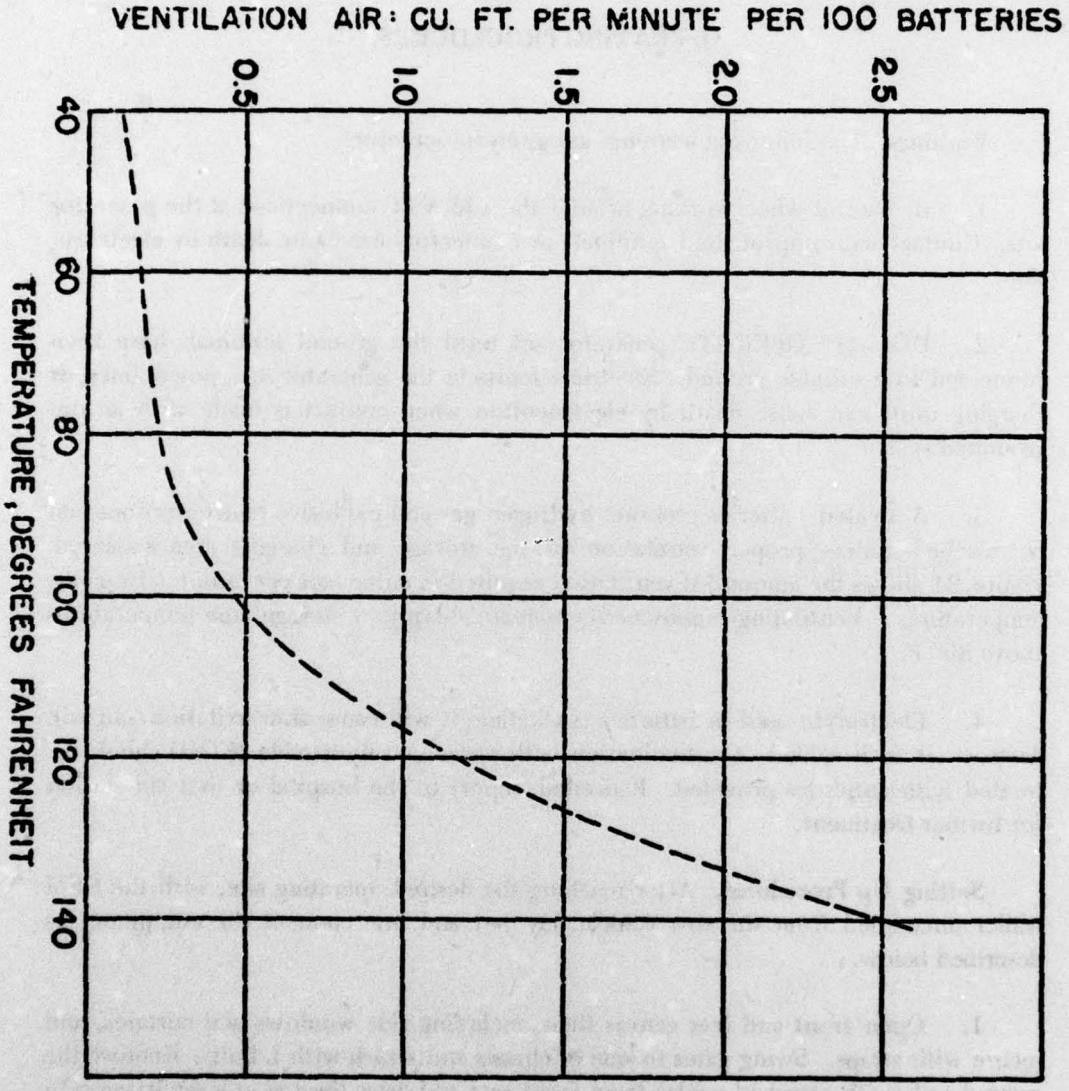

Figure B1. Ventilating Requirements

3. Connect the Battery Charging Units (BCU) to the Control Switching Box as follows (NOTE: Make sure the switch on the Control Switching Box is on the OFF position): Open the cover on the BCU, pull out the AC power cable, and connect the female end to the power cable connector of that charger. Connect the male plugs to the Control Switching Box. The AC power cables are precut and should, therefore, be used with their respective units.

4. BB-451/U to Battery Charging Unit Connections: The interconnecting cables for charging the batteries (three/unit) are located under the top cover of each BCU. Make sure that the A.C. Power Switch of each charger is in the OFF position. Connect the female end of each cable to the BCU, then attach the free (clamp) end to the respective battery by the two clasps attached to the battery. NOTE: Always disconnect unused cables from the BCU, since the prongs are exposed and could short the output power to ground, damaging the BCU.

5. External Power: If external power is to be used in lieu of the onboard generator sets, disconnect the power cord from generator 1 and connect this cord to a 100 V a.c. outlet capable of delivering 15 amps.

Controls and Indicators for Generator Set. The controls and indicators for the generator set are listed and their functions given in table 2. This list gives the modified functions of the controls and indicators shown in figure B2.

Table B1. Controls and Indicators for Generator Set

Control or Indicator	Function
Voltage Reconnection Switch*	Sets utility outputs to 100 V or 240 V; Normal is 110 V.
Load Terminals*	Disconnected and removed.
Utility Outlets*	Outputs used in place of load terminals.
Load Switch*	Turns utility outlets ON and OFF.
Variable Resistor*	Controls utility voltage.
AC Voltmeter*	Indicates voltage at utility outlets. Normal setting is 110 V.
Frequency Meter	Indicate frequency. Normal reading is 60 cps.

* Internal Modification: Load terminals are physically removed and internal wiring changed to replace load terminals with the utility outputs. Normal operation of the utility output is not available.

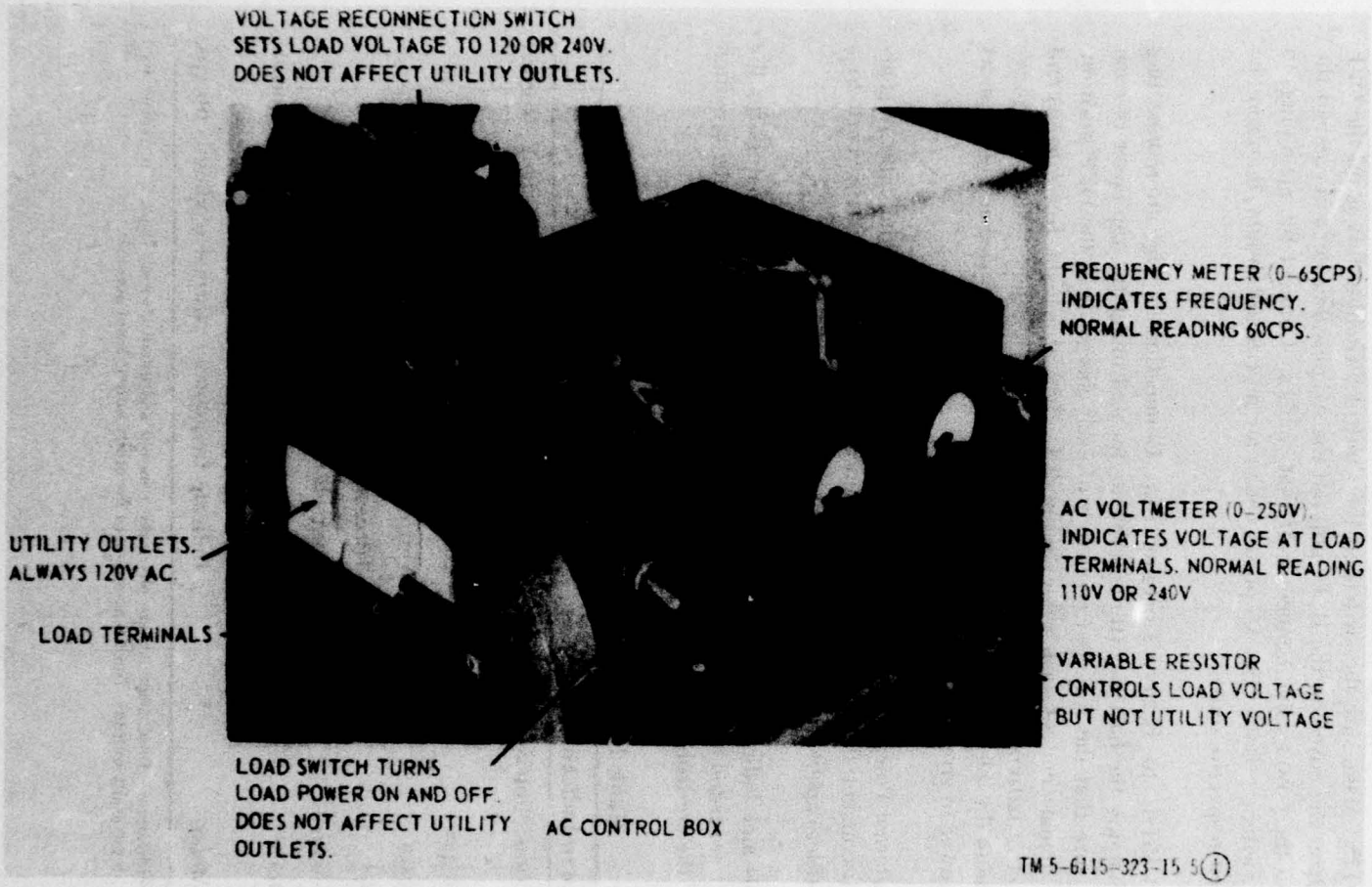

Figure B2. Generator Set Controls and Indicators

Controls and Indicators for BCU. The controls and indicators for the chargers are listed, and their functions given in table B2.

Table B2. Controls and Indicators for Battery Charger Units

Control or Indicator	Function
Power Switch	Turns power ON/OFF
Charge Current Selector Switch	Selects charge current (1.0 or 2.25 amps) supplied by the channel. When set to "START", closes lamp circuit for lamp check. When released from "START", indicates the charge at the selected rate.
Range Switch	Selects either a preset charge cutoff voltage for silver-zinc batteries, or the tens digit on the ADJUSTABLE range.
Unit Volts Selector Switch	Selects the units of the voltage cutoff setting when range switch is in the ADJUSTABLE range.
Tenth Volts Selector Switch	Selects the tenths digit of the voltage cutoff setting when the range switch is in the ADJUSTABLE range.
Charging Lamp	Indicates when the BCU is charging a battery. Lamp turns off when charge is complete.

Initial Activation of BB-451/U. Before this battery can be used, it requires an initial activation (filling the battery with electrolyte) and an initial soak cycle. Detailed procedures for these operations can be found in TM 04072A-15/1B, beginning in chapter 2, section II, para 1-5, page 1-6 of the manual.

Detailed Operating Procedures for the CEM. In this paragraph, the operation of the CEM for charging a discharged BB-451/U battery will be described. It is assumed that the trailer is parked and grounded.

The operator's initial checks and adjustments are:

1. On the desired generator, set the Fuel Selector Valve to either the "SET" or the "AUXILIARY" tank depending on which is to be used.

2. Check the fuel supply.

3. The Control Switching Box switch should be in one of the two "OFF" positions.

4. The load switch on the generator should be in the "OFF" position.

The generator engine starting procedures are:

1. Set the carburetor control to the "START and IDLE" position and the engine cutoff switch to the "RUN" position.

2. Using the starter rope, crank the engine and choke when necessary.

3. Once the engine is running smoothly, gradually move the carburetor control until the frequency meter is at 60 cps.

The preliminary charging procedures are:

1. Connect the power cable(s) from the Control Switching Box to the BCU(s). The Control Switching Box switch should be in one of the two "OFF" positions.

2. Set the load switch to the "ON" position.

3. Select the operating generator on the Control Switching Box. The corresponding light on the box should be lit.

The BCU contains three independent charging channels which may be utilized individually or in combination. The charging procedure for one channel is as follows:

1. Set the silver zinc charge cutoff voltage to 32 volts.

2. Loosen and remove the BB-451/U case cover.

3. Loosen each cell vent cap two or three complete turns, allowing any gas accumulation to escape. This prevents the electrolyte from spraying out of the cells during charging.

4. Connect a charging cable from the selected BCU channel to the battery, observing correct polarity.

5. Set the BCU power switch to ON.

6. Turn the CHARGE CURRENT selector switch to 2.25A and then to START. Observe that the charging lamp turns on. NOTE: If the CHARGING lamp does not stay on after the START operation, (1) the battery is in a harmfully discharged state or shorted, (2) the battery is at or above the selected cutoff voltage, (3) the charging connector is not properly connected, or (4) the channel fuse is burned out. Refer to the special charging techniques in paragraph 3-2 of TM 04531A-15.

7. After reaching full charge, the channel will automatically stop the charging current and the CHARGING lamp will turn off. Remove the charging cable from the battery.

8. Tighten the battery vent caps 15 minutes after the battery has been charged.

9. Replace the BB-451/U cover.

10. Using the voltmeter, test the battery to make sure it is above 29.2 volts.

The BCU shutdown procedures are:

1. Set the CHARGE CURRENT selector switch to the OFF position.

2. Disconnect the charging cable from the BCU and store the cable in the BCU cover.

3. Set the POWER/ON switch to OFF.

4. Turn the switch on the Control Switching Box to one of the two OFF positions.

5. Disconnect the power cable from the BCU and the Switching Box, and store the cable in the BCU cover.

The generator shutdown procedures are as follows:

1. Place LOAD switch to OFF.
2. Set carburetor control to START and IDLE position.
3. Place engine cutoff switch to OFF position.

Preventive Maintenance.

Generators: Daily preventive maintenance should be conducted in accordance with the instructions from TM 5-6115-323-15. Included in daily preventive main-

tenance are (1) lubricating; (2) inspecting for damage and loose mountings; (3) filling the fuel tank and checking fuel lines and fittings; (4) checking the sediment bowl for dirt, water, leakage, and cleaning the strainer; and (5) inspecting the frame for cracks.

Battery Charger Unit: The battery charger is designed to require a minimum of preventive maintenance. Once each month the exterior surfaces should be cleaned with a damp cloth. Twice each year the power and charging cables should be inspected for signs of wear. Preventive maintenance should be performed in accordance with TM 04531A-15.

APPENDIX C

MUNSON ROAD TEST RECORD

EFC-9

Date of Record:
3 July 1973

Date(s) of Test:
26 June 1973

Development and Proof Services
Aberdeen Proving Ground, MD

Authority: Test Directive
AMSTE-FA, 22 May 1973

TYPE OF TEST: USATECOM Project No. 2-ES-375-LRP-007 Customer Test – Munson Road Test for LRPDS Battery Charging System

Requesting Agency:
USAETL, Ft. Belvoir, VA.

Contract No:

Work Order No:
305-94304-03

OBJECT OF TEST

To determine if the LRPDS Battery Charging System would withstand the shock and vibrations induced by the designated sections of the Munson Road Test Course.

TEST ITEM

LRPDS Battery Charging System, consisting of the following items mounted on an M-101A1 Trailer, USA No. 6M 1311.

25 each Battery, BB 451-U, Silver Zinc
3 each Charger, Battery, PP-6241/U
18 each Kits, Electrolyte, Filling
2 each Generator, Gasoline Driven, Mil-Standard Model CE-016-AC
1 each Tool Box
2 each Cans, 5 gal, fuel
Interconnecting Cables and Control Box

TEST FACILITIES

1. Sections of the Munson Road Test Course
2. Truck, Cargo, ¾ Ton, M-37, USA Reg. No. 3E2917
3. Crane, Facilities, Bldg 315
4. Weighting Facilities, Bldg 402

TEST RECORD NO: EFC-9 (continued)

REMARKS

Before subjecting the test item to the road test, the weight distribution and center of gravity were determined and a safety evaluation performed.

The road test consisted of 5 laps on each of the test course sections as indicated below:

a. Six inch washboard at 5 miles per hour
b. Belgian block at 20 miles per hour
c. Spaced bump at 20 miles per hour
d. Radial washboard at 15 miles per hour

A physical examination and operational test were performed before and after the unit was towed over each course section.

The weight distribution was: Left wheel 1200 pounds, Right wheel 1200 pounds, Landing leg 232 pounds.

The center of gravity is located: Forward of axle centerline – 12-5/8 inches, Above axle centerline – 17-1/8 inches, Above ground – 34-1/2 inches, Laterally at vehicle centerline – 0 inches.

There are no unusual hazards associated with the equipment. It is suggested that:

a. Labels with operating instructions and suitable warnings of the hazards related to battery charging should be attached to the unit.

b. The plastic eyeshield now in the tool kit be replaced with a face shield and gloves be added to the kit.

The battery charger operated properly after the test and there was no evidence of physical damage.

This is the final report on this task.

OBSERVERS

Mr. F. L. Wilson, USAETL, Ft. Belvoir, Va.
Mr. P. Weinhold, STEAP-MT-I, APG
Mr. H. Valentine, STEAP-MT-I, APG

SIGNATURE:

/s/ Marshall T. Smith
for /t/ JAMES C. WHITE
Chief, Infantry Materiel Division, MTD

TEST RECORD NO: EFC-9 (continued)

DISTRIBUTION:
Cdr, ETL, ATTN: ETL-TD-EA (2 cys)
Cdr, TECOM, ATTN: AMSTE-FA (1 cy)
AMSTE-PO (1 cy)
Cdr, APG, ATTN: STEAP-TL (Original)

This test record signifies that the requested testing has been completed. It does not constitute approval or disapproval of the test item by Aberdeen Proving Ground.

REFERENCES

Department of the Army TM 5-6115-323-15, *Generator Set, MPF 015A*, September 1970.

Department of the Navy, U.S. Marine Corps TM 04072A-15/1B, *Battery, Storage BB-451/U*, June 1966.

Department of the Navy, U.S. Marine Corps TM 04531A-15, NAVALEX 0967-387-2010, *Battery Charger, PP6241/U*, July 1970.